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Genetic algorithm for the analysis of the stability of retaining walls

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Abstract – *The design of a retaining structure requires mastery of the laws of application of the forces and constraints acting on the structure and the calculation of the resulting constraints to ensure balance. This balance is partially guaranteed by adequate sizing to verify progressively the stability in the face of three types of instability (sliding, overturning and rupture of the ground under the foundation). If this is not the case, the check is recalculated. Given the complexity of the laws and the multitude of equations used, a mediocrity of the numerical software used in this field has been noted. Thus, this work aims to create a help tool to assist users (such as students and office engineers) in obtaining as quickly as possible an appropriate sizing proposal that ensures stability against sliding and overturning and prevents the foundation from warping and rupturing, depending on the properties of the soil and the relief of the slope. The validation of the model, designed with an expert system generator and using the C++ programming language, is based on a comparison with the analytical method. A good correlation has been obtained with a minimal difference range proportional to each parameter processed. The results have been made drawing curves of the three safety factors and their intersection possible to delimit the safety zone. As a result, the tool allows users to focus on the safety margin of the retaining wall and choose the best element dimensions.*

Keywords: *Wall retaining, Algorithm, Stability, Reversal, Reversal, Slip*

I. Introduction

Each year, the technical services of state and local authorities design and manufacture equipment to protect against natural risks. They should also rebuild public facilities (retaining and engineering structures) damaged by these phenomena because they have been built in exposed areas or challenging installation contexts. In the problems encountered in studying the stability of structures, the self-weight of the structures to be calculated is sufficiently small compared to the external forces that it can be neglected or evaluated arbitrarily in a first calculation. Thus, it is possible to determine, almost without trial and error, the suitable dimensions of the different parts of the construction.

The same cannot be said of retaining walls, for the only force they can use to oppose the pushing of earth or water is their own weight. When determining algebraically the stability conditions for a wall of a given type, by deducing the thickness at the base, formulas are reached, whose calculation is so laborious that using a trial and error approach is highly preferable. Then a suitable result can be achieved relatively quickly if the type of wall whose stability conditions are to be checked has been chosen wisely. The problem should be posed in these terms [1]–[3].

By considering the profile of a wall and the thrust it should resist, it is necessary to check whether it achieves stability conditions without excessive force. If not, it is easy to change its dimensions and check again. When it comes to a water retaining wall, whose thrust is known precisely, the masonry cube can be limited to what is strictly necessary. By contrast, it would be useless to push the trial and error process very far regarding a thrust of land whose slope nature has not been rigorously determined. Here again, the theory serves as a check on the dimensions determined by experience or empirical formulas [4]–[6].

For the design of retaining walls, basic mechanical characteristics, such as cohesion c, internal friction angle φ and soil density γ behind the wall and its support, should be determined first. The engineer should assess the lateral force acting on the retaining structure and design the retaining wall. Given the complexity of the analytical methods and the verifications to be carried out, executable programs are essential for dimensioning and stability verification. Artificial intelligence aims to simulate the human brain by making intelligent machines. In reality, these are not intelligent machines but rather intelligent programs. The precise goal of artificial intelligence is to solve problems that do not have an algorithmic solution [7]–[9]. Expert systems are sets of programs designed to reason skilfully about tasks that are believed to require considerable human expertise in a skill area. Human experts can solve problems. Their competence is based on their proficiency in the field accumulated through years of experience and their possession of sufficient knowledge to find solutions to problems.

Expert systems aim to simulate these two possibilities, reproducing human experts' activities by using a machine. The effectiveness of expert systems comes from the fact that they reason informally (with the